**AMERICAN PILOTS' ASSOCIATION**
**NAVIGATION AND TECHNOLOGY COMMITTEE**

# Portable Pilot Navigation Systems: A Best Practices Summary

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## 1. Introduction

This summary provides the basis for the development and implementation of Best Practices for Portable Pilot Navigation Systems (PPNS). These Best Practices cover philosophy, operation, technology, training, and other subjects that enhance the development and use by pilots of PPNSs. The summary is intended to serve as a generally agreed statement by the US piloting profession of Best Practices for PPNS. As such, it is subject to change.

This summary was prepared by a PPNS Best Practices Working Group of the American Pilots' Association's Navigation and Technology Committee[1]. The concepts and recommendations outlined in the summary are based upon extensive experience of APA-member pilots using Portable Pilot Navigation Systems, general engineering practices, and advice of legal counsel.

## 2. Definitions

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| PPNS (PPU) | A Portable Pilot Navigation System (also referred to as a Portable Pilot Unit) can generally be described as a portable, computer-based system that pilots bring aboard a vessel to use as a decision-support tool for navigating in confined waters. |
| GPS | An electronic Global Positioning System based on a constellation of satellites orbiting the earth at a very high altitude. Typically accurate within +/- 13 meters 95% of the time. |
| Differential GPS | Ground based, elevated-accuracy radio system developed by the USCG with a specified position accuracy of better than 10 meters |

[1] The members of the Working Group are: Captain Jorge J. Viso, pilot/member of the Tampa Bay Pilots, chairman, APA Navigation and Technology Committee; Captain Wayne E. Bailey, pilot/member of the Pilots' Association for the Bay and River Delaware, member, APA Navigation and Technology Committee; and Paul G. Kirchner, Executive Director-General Counsel, APA.

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| | 95% of the time. The USCG Differential service provides independent integrity monitoring of the GPS satellites. This form of GPS correction is the preferred method of enhancing GPS accuracy in Portable Pilot Navigation Systems. |
| WAAS | Wide Area Augmentation System is a satellite based, elevated-accuracy system developed for civilian aviation. The WAAS specification requires a position accuracy of 7.6 meters 95% of the time. WAAS provides satellite based integrity monitoring of the GPS constellation. WAAS should not be used as a primary GPS correction method in a Portable Pilot Navigation System, and should only be used as a back-up to the USCG Differential service. |
| AIS | Automatic Identification System is a system used by ships and Vessel Traffic Services and other shoreside facilities primarily for identifying and locating vessels. It also provides a means for ships to electronically exchange ship's data. GPS, without correction, is typically used to supply AIS positions. |
| Pilot Plug | Ship installed data port that provides a pilot with access to data received and transmitted from the vessel's AIS. |
| WiFi | A wireless communications technology that enables equipped devices to exchange data. For the purposes of this paper, WiFi refers to the 2.4 GHz 802.11b/g standard used in most home/small office installations. |
| Bluetooth | A more flexible wireless communications technology that shares the same frequency as WiFi but provides lesser throughput of data at generally shorter distances. |
| Laptop PC | The most common display interface used for Portable Pilot Navigation Systems. |
| PDA | Personal Digital Assistants are handheld computers with smaller screens and less computing power than Laptop PCs. PDAs typically operate with an abridged version of the standard PC operating system, and generally connect to other components via WiFi or Bluetooth. |
| Charting Programs | Software used to display Own Ship and Target Vessel positions on a nautical chart. The 3 most common types of Charting Programs are: Raster Scan Display, S-57 Vector Display, and Custom or Proprietary Vector Display. |

## 3. Overview

Pilotage is, and always has been, a local issue. What works well for a large district may be impractical or cumbersome for a geographically smaller or different area. There is no single PPNS or solution that can meet the needs of all pilotage districts. And, in some cases, use of a PPNS may not be appropriate.

The general goal of this summary is to encourage marine pilots to strive for the highest level of proficiency associated with the development and use of a PPNS. This entails not only educating the pilots in its safe operation and integration into their working practices, but also assisting pilots in the adoption of safe practices associated with the development of their PPNS.

Deviations from the Best Practices or recommendations of this paper may be appropriate in some circumstances. Pilots and their associations are encouraged to develop an explanation for a decision not to follow a Best Practice.

## 4. History of PPNS Development

The development of a portable, pilot-carried navigation system in the United States started in 1980, well before the implementation of the GPS/DGPS service and portable laptop computers. Working with engineers of the United States Coast Guard Research & Development Center and the John's Hopkins Applied Physics Laboratory, Capt. Joseph F. Bradley of The Pilots' Association for the Bay and River Delaware assisted with the development of a Differential LORAN-C navigation system that was intended to be a self-contained, pilot-carried waypoint navigation system that required only a power source from the ship for its operation. This early system weighed about 30 pounds and eventually provided position accuracies of approximately 10 meters. The navigation information provided was: Cross Track Distance in feet, Speed Over the Ground in knots, Distance to the next waypoint, and Rate of Divergence from the centerline in feet per second.

In 1991, with the emergence of GPS and the U. S. Coast Guard's Differential Service, work with the portable system was shifted from the LORAN-C based system to one based on Differential GPS. USCG R&D Center and John's Hopkins participation in the project ended at this time. Starlink Inc. and Raytheon Service Company joined Capt. Bradley in the project with the goal of turning the Portable Pilot Navigation System into a commercially viable product. Starlink engineers wrote a custom navigation program for use on a laptop computer, and integrated it with a DGPS receiver – antenna to create a self-contained system that weighed 13 pounds and required only a power source from the ship to operate. Using waypoints provided by the U. S. Army Corps of Engineers and the U. S. Coast Guard supplied Differential signal, consistent position accuracies of less than 2 meters were seen.

In 1994, the Pilots' Association for the Bay & River Delaware became the first U. S. based pilotage group to equip all of its pilots with a Portable Pilot Navigation System. In the 14 years that have followed, more than 20 U. S. pilot groups have equipped their pilots with systems produced by one of several companies. In a number of other US pilot groups, individual pilots have elected to use a commercially available system.

## 5. Portable Pilot Navigation System Configurations

The following are the most common configurations available and employed by pilots:

- DGPS/Charting Program: This basic configuration provides a representation of Own Ship position on a chart display of varying detail. Position accuracy may be enhanced by the use of corrections coming primarily from the U. S. Coast Guard Differential Service.

- DGPS/Charting Program/Self-contained Transponder or AIS: A proprietary transponder system added to the basic GPS/Charting configuration provides some other vessel positions in addition to Own Ship position. These systems were used under the 825 and 1371.1 AIS protocols. Another variation utilizes an internet based server operating as a Virtual Private Network. Vessels that are displayed must have similar transponder units on board.

- DGPS/Charting Program/AIS Input via Pilot Plug: Other vessel positions are added to the display of Own Ship Position on a chart. Target Vessel location and data is received from the Own Ship's AIS through a connection to the Pilot Plug. Own Ship Gyro Heading may also be obtained through the Pilot Plug.

- Charting Program/AIS Input via Pilot Plug: The display of Own Ship Position on the chart is totally dependent on the ship's GPS and AIS equipment.

The priority of own-ship positioning display over AIS target display, or vice-versa, will greatly influence the hardware and software choices made within these general configurations. Similarly, the need for, and availability of, detailed hydrographic information or other area-specific information will drive the selection and configuration of many components. Charting programs, whether supplied by the system integrator or commercially obtained, should be tailored to the specific needs of the pilot group and area of operation.

## 6. Development

The successful development of a PPNS starts with identifying the navigation needs and issues for a given pilotage area. Where PPNSs have been most successfully incorporated into piloting practices, the pilots took the lead in selecting the units and tailoring them to their particular requirements. Development of any system, however, should involve other partners outside of the pilotage organization who are capable of providing the required technical expertise and advice.

There are many policy and system configuration choices that need to be made during the development of a system. While not all-inclusive, consideration should be given to the following:

- A committee of veteran pilots with varying levels of computer experience should be formed to determine the pilot group's priorities in developing the system. When addressing the complexity of the system to be developed, the committee should consider the operational experience of the intended users.

- A manufacturer or system integrator with the resources and expertise to provide a reliable system that is capable of attaining the required accuracy should be selected to work with the committee.

- The system's computer, components, and programming should be dedicated to navigation related activities. Limited User Accounts, as opposed to Administrative Accounts, should be employed to prevent users from having the ability to load or change software, or access and change configuration settings. Software and hardware controls should be put in place to prevent unauthorized parties from accessing any part of the system. Distribution of passwords for administrative control of the system should be kept to a minimum.

- Data sources for waypoints, soundings, aids to navigation, etc:
    - Government: USACOE / USCG / NOAA / Local Port Authority.
    - Corporate: System vender, component manufacturer, or programmer.
    - Private: pilot or pilots' association.

  Official government sources should be used whenever possible. There may be times when a corporate source may be acceptable, providing the supplier of the data can establish the credibility of the source. Pilots and pilot associations should avoid supplying data, but may assist with locating reliable sources.

- Standardization: It is essential that all systems in a given pilotage area contain and display the same waypoints, routes, and aids to navigation. It is also essential that individual pilots not have the ability to alter or add to

the waypoints, routes, and aids to navigation in their system. It is acceptable for a program to allow individual notations on a display providing the notations do not impair or impact the normal viewing and operation of the system.

- Required standard of accuracy: The pilot group or association should determine the position accuracy required for the area and type of work performed, and select the positioning device(s) and display type or mode that will most reliably meet the standard.

- Systems that are capable of displaying Own Ship position from more than one positioning source should have a means of displaying and or comparing multiple Own Ship positions at the same time, with the most accurate positioning source being clearly identified.

- Warnings or alerts to advise the user of positioning errors or problems in the system should be incorporated where possible. Visual warnings should be accompanied by an audible alarm.

- Recording of trips: The recording and archiving of trips may be required by local regulation. In the absence of mandated recording and archiving of trips, the pilot group's legal advisors should be consulted for guidance.

- Connection methods between components will vary depending on manufacturer and components selected. The method(s) selected should reflect due regard for optimal reliability and ease of setup. In cases where a WiFi or Bluetooth connection is employed for the link between the primary navigation sensor and the system display, it may be advisable to have a cabled backup.

- Extensive, real-time, in-the-field tests of the proposed system should be conducted prior to general deployment.

## 7. Training

The common maritime industry practice of supplying a mariner with a piece of equipment and an instruction manual, but no formal training on the equipment, cannot be regarded as a proper or safe procedure for a PPNS. Even in the absence of a specific regulatory requirement that a pilot be trained in the use of a particular piece of equipment, the inability to competently use an available resource, particularly one brought aboard by the pilot, may under some circumstances constitute negligence. Pilots should be trained prior to their first use of a PPNS, and they should receive supplemental instruction any time their hardware or software configuration has an appreciable change.

The amount and type of training required prior to using a PPNS will vary depending on many factors. Typically, systems that display more information and that require more interaction from the user will need greater amounts and higher levels of training.

Some of the factors to be considered in determining the type and amount of training are:

- Type of positioning or navigation tool– GPS/DGPS/GPS with WAAS
- Type display device – Laptop PC/PDA/Hand-held or portable GPS/etc.
- User interface – Windows (MAC) OS/PDA or PALM OS/Manufacturer's Proprietary System.
- Type of display format – Text/Graphical/Charts (raster scan or S57)/Manufacturer's Custom System.
- Connectivity method(s) of equipment – Wired/WiFi/Bluetooth.
- Intended area or environment of use.
- Other tools combined with the navigation system – AIS/Pilot Plug.

Training topics should cover the theory behind the selected positioning device(s), an extensive hardware and software orientation, principles and use of Electronic Navigation Charts and AIS (when equipped), and integration of the equipment into the pilot's Bridge Resource Management practices.

It should not be assumed that because a component of a PPNS may be commonly used in another facet of everyday life, training on that item or area can be eliminated.

## 8. Deploying a PPNS in a Pilotage Area

Pilot organizations generally deploy their Portable Pilot Navigation Systems in one of two manners:

- Acquire a system for each pilot in the organization and issue each pilot a unit for his or her exclusive use, or
- Acquire a number of systems sufficient to cover the anticipated vessel movements at a given moment, and provide each pilot assigned to a vessel a means of taking a system to the vessel.

Most Associations that start with systems that are shared among pilots (Library System) tend to acquire additional systems in order to provide each pilot with his or her own

system. Logistical difficulties with pooling of the systems are the reasons commonly cited for acquiring additional systems.

Regardless of how the systems are assigned, a number of spare systems should be kept on hand to provide for backup when systems are unavailable, damaged, or in need of service.

## 9. Maintaining a PPNS

Absent official guidance from a regulatory source, pilot organizations deploying a PPNS should work with the supplier of their system to enact measures that ensure the systems their pilots carry are maintained in good working order.

As a practical matter, a system for diagnosing and correcting any day-to-day problems with systems should be established. Likewise, a system for periodic maintenance checks and software or hardware updates should be established. It is recommended that as much of the maintenance as possible be done either by the manufacturer/supplier or by qualified IT servicing providers.

If equipped with Wireless Broadband Internet Service, technicians can remotely access and service systems through a Virtual Private Network. VPN for administrative or service purposes should not be enabled or used while a system is in use aboard a vessel.

A pilot group should maintain a supply of spare parts so that pilots can easily replace lost or damaged components such as carry bags, antenna cables, or power supply adapters. It may also be advisable for pilots to carry spare batteries, power cords, or other ancillary equipment as needed.

Up to date equipment assignment records, maintenance logs, and records of software and hardware updates should be kept.

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